the week April 14–20 and May 5–11, are the only ones at hand, but will illustrate the slight importance of melted snow as compared with rain.

Up to April 14 the river remained low; the discharge was a little over 100 cubic feet per second. The warm, clear days of Friday, Saturday, and Sunday caused a more rapid melting of snow and an increased volume in the river on Sunday, Monday, and Tuesday. The average for Monday, April 20, was unusually large for this season. The reports indicate that there is little snow left on the mountains below an elevation of 8,000 feet. The amount of snow has been greater than usual, and the total amount of water received (namely at the gauging station) will be greater than for a number of years. Nevertheless there will be the usual scarcity late in the season.

From the bulletin for May 5–11, we quote:

The week having proved a warm one with the temperature of 70° and above, each day at the Agricultural College, and 55°, or over, at elevations of 9,000 feet, the melting of the low-lying snow has proceeded rapidly and the river has exceeded the flow for the corresponding week even in the exceptional year of 1885. The self-recording instruments show that the high water due to the melting of snow at midday on the mountains now reaches the gauging station in the canyon about 5 a. m. of the subsequent day.

The following averages are copied from these bulletins:

Discharge in cubic feet per second of the Poudre River.

Date.	1897. Daily average.	1897. Daily maximum.	Average for 1896.	Average, 10 years.
Wednesday, April 14	128	138	93	145
Thursday, April 15	158	184	124	155
Friday, April 16	173	180	140	160
Saturday, April 17	214	233	145	169
Sunday, April 18	247	364	120	208
Monday, April 19	470	571	109	220
Tuesday, April 20	450	480	114	239
Average for week	270	....	120	185
Wednesday, May 5	1,163	1,240	522	612
Thursday, May 6	1,251	1,321	708	686
Friday, May 7	1,427	1,502	946	748
Saturday, May 8	1,486	1,579	1,125	821
Sunday, May 9	1,472	1,602	....	916
Monday, May 10	1,439	1,546	....	1,000
Tuesday, May 11	1,458	1,568	....	930
Average for week	1,385	....	....	816

Averages for the corresponding weeks in previous years.

Year.	April 14–20.	May 5–11.	Year.	April 14–20.	May 5–11.
1884	146	911	1891	109	143
1885	204	1,358	1892	....	....
1886	....	773	1893	....	....
1887	294	....	1894	....	977
1888	136	354	1895	344	962
1889	93	283	1896	121	*825
1890	157	722	1897	270	1,385

* From the average for 14 days.

SNOWFALL IN COLORADO.

In connection with the preceding subject the most accurate estimates of the amount of snowfall become important. Mr. F. H. Brandenburg of the Weather Bureau, section director for Colorado, on March 10, issued a special snowfall report for that State. In addition to the data furnished by ninety voluntary observers he has received special snowfall returns from about two hundred and fifty special correspondents. According to these over the upper drainage basin of the Arkansas, in general, the snowfall has been greater than last year, and in many cases greater than for many years and large quantities of snow water will be held in reserve. Over the South Platte drainage area much more snow than usual, and the heavy snow slides in the timber will cause it to remain longer than usual. On the Continental Divide, over Clear Creek and Gilpin counties, the fall has been less than the average. Over the upper Rio Grande Basin snowfall was comparatively light, but lower down there was a marked excess. Over the Gunnison River watershed snowfall has been deficient. On the average for the whole eastern slope of Colorado the available water supply will be above the normal.

EVAPORATION AT FORT COLLINS, COLO.

In the Annual Reports of the experiment station at Fort Collins for 1889, 1890, and 1891 (which is the last at hand) details are given as to the measurements and experiments made in order to determine the amount of evaporation, in open air tanks, as well as in the running water of canals. The evaporation from tanks in the sunshine must depend upon the wind at the surface of the water, on the temperature of the water surface, and on the dryness of the air that blows over it; in place of exact measurements of these data approximate values had to be used. The report of Professor Carpenter states that the evaporation expressed in inches of depth of water in twenty-four hours may be computed by the following formula:

$$E = 0.39\ (P - p)\ (1 + 0.02\ W)$$

where P is the vapor tension corresponding to the temperature of the surface of the water; p is the vapor tension actually observed in the free air; w is the movement of the wind in miles, in twenty-four hours, at the surface of the water. In computing daily and monthly averages the mean temperature of the water surface is assumed to be the mean between the observations made at 7 a. m. and 7 p. m. The wind was measured by means of the anemometer on a tower a hundred feet distant. The moisture present in the air was deduced from dry and wet bulb thermometers. The coefficients 0.39 and 0.02 give a computed evaporation that is generally within 10 per cent, and on the average of the year is within 2 per cent of the measured evaporation. During 1890 the average daily evaporation from a 3-foot tank sunk in the ground was 0.15 inch. During 1891 the daily evaporation ranged between 0.18 in July and 0.02 in December.

HAIL AND A RAIN GAUGE FOR ITS MEASUREMENT.

The voluntary observer at Beaver in Oklahoma is quoted in the April report of the Oklahoma section as follows:

On the 27th heavy hailstorm came directly from the west, rain lasted twenty minutes, and fully an inch of hail fell; the ground appeared covered with snow. Hail drifted in places to 6 inches deep; 0.70 inch of rain was in the gauge, but no hail, and I estimated the melted hail at 0.30. Hail certainly all bounded out of the gauge as examination was made immediately after the rain ceased.

The difficulty of securing an accurate record of rainfall has led to several improvements in the construction of the rain gauge, the most important of which was the shielded gauge described by Prof. Joseph Henry as early as 1853, and the other form of shielded gauge devised by Professor Nipher in 1878. These shields are intended to protect the gauge from the loss of rainfall by the action of the wind at the mouth of the gauge. Very nearly the same protection against the wind results from the use of the protected gauge introduced by Boernstein and favorably reported upon by Wild and Herrmann.

Another source of error is due to the spattering of raindrops that are broken up into small rebounding particles by striking the ground. The spattering slightly increases the catch of the gauge, whereas the wind effect diminishes the catch to a very appreciable and sometimes a very large extent. A third source of trouble is that brought to mind by the above quotation from the Oklahoma report. Not only do the elastic hailstones bound out of the gauge, but large drops of water may easily do the same if the gauge is improperly constructed; if the drops do not bound outward as a whole, they may still break up and be partly lost as outward spatter. The remedy for this must consist in setting the bottom of the gauge, or the sloping funnel of the receiver, so far below the mouth of the gauge that drops and spatter and hailstones can not easily bound out and be lost.

In order to catch and measure hail separate from the water, or in order to prevent the hail from melting and becoming indistinguishably mixed with the rain, some special form of gauge is needed, such as has not yet been invented and we commend this problem to the ingenuity of our readers. A layer of some soft substance at the bottom of a simple cylindrical gauge, such as we use for catching snow, would probably prevent the loss of the hail by the rebound or the breaking of the hail by a violent shock, but it would not prevent the melting of the hail by the rain that usually falls with it. As an experiment we think it would be worth while to try a separate special hail collector to consist of a cylindrical bag, 5 or 8 inches in diameter and 2 feet long, hanging freely suspended from a firm ring or hoop fastened horizontally between two posts at a few feet above the ground. The wind will deflect such a bag from the vertical, so that hail falling into it will be apt to strike the sides and glide to the bottom with diminished momentum without breaking; the rain that falls will of course pass through the bag without melting much of the hail, and, in fact, if the observer is at hand, he can rescue the hail and measure it promptly before much loss has occurred.

One of the curious phenomena with regard to hailstones is the fact that at the center each stone includes a bubble of gas under very great pressure. It is worth while to melt hailstones in a mixture of soap and water, and observe the relative diameters of the bubbles of air when inside the hailstones, and again after they have been liberated. The sudden expansion of the bubbles as they escape has been found to indicate that the air is imprisoned under a pressure of several atmospheres. This could only happen in case the hailstone is made of water that has been frozen from the outside inward, thus driving its imprisoned air to the center. Another evidence of the pressure existing within a hailstone is said to be shown by examining the optical properties of a section, as can easily be done by using a beam of polarized light.

IGNIS FATUUS OR JACK-O'-LANTERN.

This title is given to flickering flames and dancing balls of fire seen at nighttime in marshy places. The phenomenon appears to be rare in the United States, but common in some parts of Europe, probably owing largely to geological peculiarities as affecting the nature of surface soil. The light is undoubtedly caused essentially by the slow oxidation of gases containing some combination of phosphorus. Such gases, of course, result from the decomposition of animal and, more rarely, of vegetable matter. This is probably the explanation of a phenomenon recorded in the Evening News of Detroit, April 6, as having been observed near Lee, Mich. The newspaper account says:

> Between 10 and 11 o'clock the other night a bright light was seen emerging from the river [possibly the Kalamazoo River in southeastern Michigan]. On first sight it was thought to be a lantern, but further investigation proved it to be a ball of light about as large as a large hen's egg floating through the air, about 10 feet from the ground, with whizzing sound and zigzag motion. It soon disappeared.

Although, under some circumstances, there occurs a form of lightning electric discharge known as "ball lightning," yet it is not likely that this was the case in the present instance. Both the ball lightning and the ignis fatuus belong to the rare and curious phenomena of meteorology. Although they have no important relation to climatology or to dynamic meteorology, yet they are always worthy of record. From the standpoint of the electrician, ball lightning is a phenomenon whose nature is as yet totally unknown, and a satisfactory explanation thereof is greatly desired.

CURRENT WEATHER AND FUTURE CROPS.

An average state of weather is expected to produce an average crop and when some condition that seems abnormal occurs, the people are full of apprehension that the crops will be greatly diminished and of inferior quality; prices go up, speculation is rife, and the croakers have it all their own way. But after a few weeks nature restores the injury that was done, and before Thanksgiving day comes around those early fears are all dissipated by the sight of the bountiful crops. The really serious injuries to the crops almost invariably occur late in the growing season, when there is no time left to repair the damage.

Mr. J. M. Broadfield publishes several illustrations of this principle in a letter to Mr. George E. Hunt, Director of the Georgia Climate and Crop Service, and published in the Georgia Review for June 15, 1896. Mr. Broadfield says:

> The year 1818 was very fatal to all crops; no rain from the last of March till August; 1839, no rain from the 1st of April till 3d of July, and every farmer gave it up, that it was impossible to make but little, if anything. But the rains set in the 3d of July, and it rained every day for two weeks, and, to the astonishment of all, more cotton was made that year than any previous one. Corn took on new life, and a very heavy crop was made. In 1845 the drought set in about the last of March or 1st of April, and no rain till middle of August. Farmers planted corn, peas, turnips, etc., after rain set in, and made enough to fatten hogs—from the late planting. I remember we had no frost that fall till 28th of November.

April and May, 1896, were the next most remarkable departures from the normal weather conditions.

SECULAR CHANGES IN CLIMATES AND CROPS.

The meteorologist appeals to his records of observations in order to detect any change in climate, but the agriculturist naturally puts more faith in the appeal to the records of crops and vegetation. The latter may be called a practical test of the permanency of climate, but it is also very liable to be a deceptive one. The thermometer is a very simple instrument compared with a plant. The records of freezing temperatures apply directly to the climate while the records of frost-bitten plants must be interrupted by taking into consideration the nature of the plant, its stage of development, the moisture in the ground, the dryness and windiness of the air. The principal uncertainty with regard to the record of a thermometer relates to our possible ignorance of its height above the ground and the extent to which it is shielded from radiation of heat. On the whole it must be confessed that the imperfections of thermometric records are quite serious and that when it comes to a question of what the climate was fifty or a hundred years ago phenology has about as much weight as thermometry.

But any record of any climatic feature is sure to show a wide range of extremes in the course of fifty years, and the question of a real change in climate can not be settled by quoting a few such extremes. It has been well pointed out by Professor Bailey, in the MONTHLY WEATHER REVIEW for September, 1896, p. 330, that phenological records have no special value to the botanist or botanical physiologist, but their proper use is to determine average climatological conditions. If, for instance, we knew the average date of leafing or blooming or ripening of any plant for the past fifty years, and again for the preceding fifty years, the comparisons of these averages, having proper regard to the index of annual variability, would give as clear an idea of the possible change in climate as if we had corresponding records of the temperature, sunshine, and rainfall. It is true that the climate has made the plant, and that if we knew enough about the physiology of plants, we might utilize meteorological records to explain botanical peculiarities, but, practically, we can not do this with any safety. The phenologist must be allowed to consider his observations of plants as being a record of